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# Space R&D to Enhance Life in Emerging Space Countries in Africa and Latin America

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**Abstract**

Recently, "middle economy" countries in Latin America and Africa have expressed growing interest in developing indigenous space programs and independent space-faring capacities. Concurrently, the space sector worldwide is experiencing massive disruption by way of the introduction of commercial players. The presence of commercial space companies, domestic and foreign, will play a unique role in the advancement of countries along the Space Technology Ladder (STL). This paper will examine the current landscape of commercial space activity in countries in Latin America and Africa as well as the government's response to the rise of the industry. A survey of the foreign and domestic industry players in each continent will be provided. In addition, this paper will analyze private-public partnerships and policies that can provide insight into the role government is playing in facilitating or hindering the growth of a sustainable space economy. This analysis will provide a breakdown of commercial space activities and analysis of the subsequent government response, serving as a resource for other countries developing policies for interacting with industry.

**Keywords:** Latin America; Africa; Space; Research and Development; Emerging Countries

## 1. Introduction

Latin American and African countries are facing a crucial turning point in their development. In Latin America, most countries in the region are no longer in early stages of development, with 40% of the population classified as middle-class. As countries transition from lower to higher income groups, however, they may face challenges in other dimensions of development. For example, countries in the region must find a path towards digitization, as only 57% of Latin Americans are currently connected to the Internet [1]. Failing to address these challenges could lead to reverse transitioning (as was the case with Venezuela which, after achieving high-income status, reverted to middle income in 2015), or fall into the so-called "middle-income trap", a phenomenon where countries face long-lasting slowdowns in growth as they approach middle levels of per-capita income [2]. At this stage of development, countries facing uniquely complex challenges could benefit greatly from the solutions offered by space applications. Latin American countries have already recognized the significant socioeconomic benefits reaped by established space nations (such as US and India), and there is growing interest in how they may be able to recreate such success through indigenous programs. Despite this increased interest, countries in Latin America have struggled to develop sustainable space programs and foster what little commercial activity there is. Now, however, policy makers and government officials wishing to take advantage of space-based applications have access to a multitude of options. Importantly, investing in indigenous, traditional space programs is no longer the only means of benefitting from space. Especially with the rise of global commercial space sector, there are increasingly diverse options with regards to the types of missions, sponsors, and providers available. Furthermore, due to crucial developments in launch and nanosatellite technologies, the cost of placing and operating assets in orbit has been dramatically reduced.

Still, due to the high costs involved and risks associated with space technologies and implementation, governments will continue to play an important role in defining the space agenda for Latin American and African countries. For the regional industry, the development of any indigenous commercial space activities will largely depend on the country's innovation system, access to capital and international markets, something that is influenced greatly by government policies, regulations, and investment. For international commercial providers looking to gain access to Latin American markets, the government will

generally be the main (or first) customer. Thus, understanding the current space sector in Latin America requires an examination of commercial space activities in the context of government policies and the broader national research and innovation strategy. Understanding the goals and objectives of governments in Latin America, especially as related to the space strategy, is paramount in understanding how the commercial sector may develop. Here, a survey of the commercial industry in Latin America is presented followed by an analysis of the general government strategy towards space, and how this strategy will affect the development of the broader space industry on the continent.

Following this, a similar approach is taken regarding the African continent. There, apart from rapid progress made in a few key countries, space efforts tend to be in their fledgling stages, but both the African Union and its individual member states have reflected a realization of the importance of space in meeting their development goals. This can be seen in continental efforts to set up an African Space Agency (AfSA), hosted by Egypt, the adoption of the African Space Policy and Strategy, and the inclusion of an outer space strategy as one of the 14 key flagship projects of the Agenda 2063.

## 2. Commercial Space Survey (Latin America)

The vibrancy of the commercial space sector has vastly changed the space economy landscape. In 2016, three quarters of the $345 billion of global space revenues were commercial in nature. As defined by the OECD Space Forum, included in this figure are activities in space manufacturing and satellite operations as well as consumer activities derived from government-sponsored research and development in the space sector. Along with the rise of commercial space, the global space industry has also seen diverse new entrants in the sector, particularly with the emergence of activities in developing nations. In Latin America, indigenous and foreign commercial space players are becoming more active, as demonstrated in the sector analyses below.

### *2.1 Selected Commercial Companies in Latin America*

Historically, companies operating in the space industry in Latin America have been state-owned enterprises, largely focused on satellite manufacturing and operations, and led by countries such as Venezuela and Argentina. More recently, there is increased interest in developing a regional launcher and a growing number of NewSpace companies with innovative practices. A survey of selected companies is presented below.

| Company | Sector | Country | Description |
|---|---|---|---|
| INVAP S.E. | Satellite manu-facturing and operation | AR | State-owned enterprise, first company in Latin America certified by NASA to supply space technologies. Manufactures satellites, payloads, and ground stations. |
| AR-SAT | Satellite manu-facturing and operation | AR | State-owned tele-communications and satellite company. |
| Airvantis | (New-Space) Research and Develop ment | BR | Aims to send the Brazillian probe to the moon and conduct microgravity experiments. |
| Institute of Aero-nautics and Space (IAE) | Launch | BR | The institute, housed under the Department of Aerospace Science and Technology, develops projects in the aeronautical, airspace, and defence sectors, and is partly responsible for the execution of the Brazillian Space Mission. Currently developing the VLS-1 satellite launch vehicle, the first of its kind in Brazil. |
| ENTEL | (Down-stream) Telecom municati ons | CL | Largest tele-communications company in Chile. |

| | | | |
|---|---|---|---|
| Sequoia Space | Satellite services (hard-ware and software) | CO | CubeSat developer and satellite mission provider and consultancy. |
| Ideatech | (Down-stream) Earth Obser-vation | CO | Platform development for Earth Observation applications. |
| VENG | Launch | AR | |
| Satellogic | Nano-satellite Manu-facturer | AR | Manufactured Argentina's first two nanosatellites. |
| ArsUltra (and partners) | (Up-stream) R&D for Space Com-ponents | AR | |

*2.3 Challenges Ahead for Commercial Space Players in Latin America and the Role of Governments*

As the space industry becomes more globalized and diverse, both incumbents and new entrants into the sector from Latin America will have to compete in a global value chain defined by rapid technological development. Innovation and research and development, bolstered by government policies and investment, will be as important as production and distribution to ensure global competitiveness. Although the Latin American commercial industry is comprised of a variety of players at different stages of development, similar challenges lie ahead for both incumbents and new entrants into the space economy. As the global value chain continues to grow, competition will increase in almost all sectors. According to the OECD, these global value chains "deepen the process of globalisation along three different lines: geographically (by including a larger number of countries, including emerging economies), across sectors (by affecting manufacturing but also increasingly services industries), and functionally (by including not only production and distribution but also R&D and innovation)" [3]. Governments must be aware of these challenges, and provide solutions if they intend to support growth for the local industry.

A first step in developing policies to benefit local industry is often coordinating activities and integrating into a regional value chain. Global markets are changing, but the upstream segment will continue to be influenced by R&D policy decisions of national governments as the downstream applications serve larger, global markets. Therefore, national administrations have to understand the complete supply chain to develop strategies to integrate into global value chains. In Latin America, the first challenge to overcome is developing an understanding of the local industry in order to try to increase coordination. As the President of the El Salvador Aerospace Institute Luis Erique Salaverría noted, it is crucial to "identify and support those early actors [in the space industry], such that they can truly make a difference in their respective countries."

In Mexico, policies adopted by the government have been extremely effective in improving the productivity and competitiveness of manufacturing and services sectors with respect to the aerospace industry. After investing in federal and state-level policies to promote innovation, Mexico has become a global hub for multinational aerospace manufacturing firms such as Boeing, Airbus, and Rolls-Royce [4]. Annual foreign direct investments have grown from USD 250 million in 2004 to over USD 1 billion in 2011. Aiming to recreate the demonstrated success of the aerospace agency, the Mexican space agency, AEM, is working to coordinate and build upon Mexican efforts in the space sector, focusing on international scientific and satellite remote sensing initiatives. Since the 1990s, Mexico has focused on developing commercial communications services. Satélites Mexicanos (Satmex) is a private company established in 1997 providing commercial communications services. It currently has an 11% market share in Latin America, and was acquired by Eutelsat in July 2013 for more USD 1 billion [5].

The Brazilians have also expressed their desire to increase integration and coordination in space industry efforts, as demonstrated by their statement at the 3rd International Space Forum of 2018 held in Buenos Aíres,

> "We are also developing government actions that can encourage strategic partnerships and integration of R&D institutions with the industrial sector. Our primary goal is to qualify the national industry for the development and manufacture of subsystems and complete systems for the space sector and, thus, to involve national companies in the Brazilian Space Program...jointly carrying out technological development projects that include industry from the design stage. It is also necessary to seek the approval of long-term plans that allow national companies to decide, with less uncertainty, on participation

> in the Brazilian Space Program. In this sense, the use of PPP [public-private partnerships] as a financing alternative for space projects has proved increasingly efficient in the international scenario."

Brazilian officials recognize the importance of governments in supporting burgeoning industry, especially through developing long-term programs that integrate industry into the national space program. Other countries in the region have demonstrated interest in developing programs to support industry as well. In Colombia, Ruta N (Medelliín's Science, Technology and Innovation Foundation) launched Medellín Espacial (Medellín in Space), to support startups and university research projects working on business ideas in the aerospace industry. Venezuela was undergoing assessment to establish a research center for small satellite technologies, promoting research networks and the development of space projects with participation of other, local industries in areas such as materials science, chemistry, telecommunications, and others.

However, even with these initiatives, concerted efforts towards integrating and supporting the industry have not been made. For example, in Colombia, most of the activity in the space sector has been led by the academic and private sectors, highlighting the need of the Colombian government to more actively involved managing and supporting financially this type of initiatives. Industry players across the continent generally state that there is a growing need for governments to play a role in coordinating and promoting local industry activities, especially with funding. Without this high-level support, especially since financial resources are severely limited, becoming globally competitive will become increasingly challenging.

### *2.4 Foreign Commercial Companies in Latin America*

Another trend in Latin America is the growing presence of foreign commercial entities, offering services to governments in the region in lieu of traditional, government-to-government partnerships. Notable countries and companies offering services to Latin American countries include China (China Great Wall Industry Corporation) and Europe (Airbus). SES, a satellite operator based in Luxembourg. Partnering with Entel, the largest telecommunications company in Chile, together they brought satellite broadband connectivity and 4G to residents on the isolated Easter Island, 3,512 kilometers off the coast of Chile [6].

The United Kingdom Space Agency's International Partnership Programme serves as a useful case study for fruitful modes of collaboration on the continent. IPP began as a five-year £152 programme designed to raise awareness regarding the types of sustainable development problems that can be solved using space technologies in developing nations. The programme has successfully partnered burgeoning space companies in the UK with developing countries to solve developmental issues. For companies, the value added is the ability to learn how to apply solutions in an international context, developing useful skills for international business. As well as incentivizing them to recognize the presence of unique problems in developing nations, Latin America's developmental problems are well-suited to be addressed by space applications. The problem remains finding sustainable funding streams to continue supporting such partnerships.

International collaboration initiatives in the African continent also serve as useful examples for Latin American countries looking for more sustainable partnerships. Agreements between African nations and entities such as the UAE Space Agency, Surrey Satellite Technology Ltd and companies such as Zero 2 infinity have been established by Algeria to promote training and general development in the space sector [see 7]. The next section will consider some further relevant developments in Africa.

## 3. African developments

As mentioned in the abstract, the Space Technology Ladder, created by Wood and Weigel [8] is a useful measure for tracing the advancement of countries in the space sector. In a recent study that was conducted on the African space sector (and the related African international space ecosystem, national space infrastructure, related activities, and capabilities), a modified Space Technology Ladder was presented [7]. This modified ladder includes additional milestones such as first national space policy, and the establishment of a domestic space sector (Table 1).

Table 1. Modified Space Technology Ladder

| | |
|---|---|
| 4. Launch Capability | 16. Astronaut to space |
| | 15. Satellite to GEO |
| | 14. Satellite to LEO |
| 3. MEO/GEO Satellite | 13. Build locally |
| | 12. Build through mutual international collaboration |
| | 11. Build locally with outside assistance |
| | 10. Procure |
| 2. LEO Satellite | 9. Build locally |
| | 8. Build through mutual international collaboration |
| | 7. Build locally with outside assistance |

| | |
|---|---|
| | 6. Build with support in partner's facility |
| | 5. Procure with training services |
| 1. Establishing Space Policy, Agency and Infrastructure | 4. Establish space AIT centre/space industry |
| | 3. Establish current national space agency [critical factor for High/Medium/Low Space Technology Countries] |
| | 2. Establish first government space office |
| | 1. Establish first government space policy |

A variety of other frameworks were also applied in the analysis of the African continent's space sector including Harding's Emerging Space Actor (EMSA) framework [9] and the European Space Agency's Technology Readiness Levels [10]. It was determined that strong upward trajectories in technical and managerial autonomy and complexity could be identified, particularly in Algeria, Egypt, Nigeria, Kenya, and South Africa, and to a lesser (but no less significant) extent in Angola, Ethiopia, Tunisia, Morocco, and Ghana, with other countries showing promise as well [7]. As an example, see Fig. 1, showing the analysis for the member states of the Arab Maghreb Union – one of the eight African Regional Economic Communities.

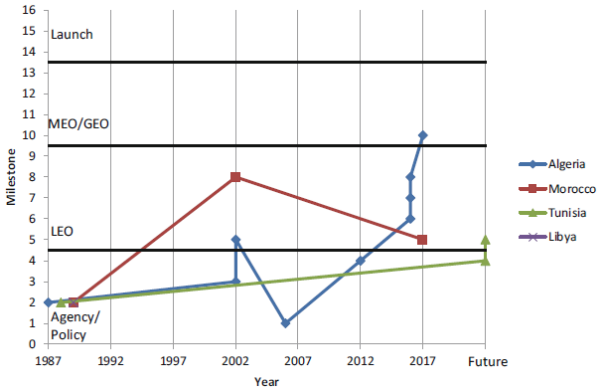


Fig. 1. Milestone timeline—Arab Maghreb Union [7]

As can be seen from the Space Technology Ladder, an important component in the advancement of national technical and managerial autonomy and complexity of space activities is collaboration with external (primarily non-governmental, commercial) partners in procuring training services and manufacturing of satellites. Multiple examples can be identified of this across the African continent, but one of the best examples demonstrating the importance of commercial R&D partnerships in space is, as mentioned above, Algeria.

In a forthcoming volume on integrated space for African society [11], detailed space sector analysis is presented for 17 African countries, including Algeria. Algeria has positioned itself as one of the leading space nations in Africa by placing an intense focus on training and domestic capacity building in all their foreign relationships with an underlying drive to build up more independent capabilities through commercial partnerships. For example, the first Algerian satellite, AlSat-1 (2002), was purchased from and built by Surrey Satellite Technology Ltd (SSTL) in the UK, and included a training package for 11 Algerian scientists and engineers [12]. Similarly, the second Algerian satellite, AlSat-2 (2010), was also built in partnership with a foreign manufacturer, Airbus Defense and Space (EADS Astrium at the time), and included the training of 30 Algerian engineers, as well as six Doctoral and eight Masters students [13, 14]. In 2016 Algeria acquired three more satellites. AlSat-1N (Nano) is a 3U CubeSat of 3.5 kg, and is the work of a joint Algerian-British team in line with a cooperation framework between the Algerian Space Agency (ASAL) and the United Kingdom Space Agency (UKSA). Algerian students were involved in the project as part of an education program at the Surrey Space Centre, and a vital component of this small satellite is that ASAL is responsible for its operations—a common theme for the other two satellites launched in 2016, and a demonstration of increasing Algerian space systems capabilities. AlSat-2B was integrated in Algeria and demonstrates the success of the training and technology transfer program that was part of the contract. Indeed, Airbus (the partner on AlSat-2B) recognized the extent to which the Algerian engineers and scientists were able to take what they had learnt from the first AlSat-2, and use it domestically to integrate AlSat-2B, when it was observed that "ALSAT 2B's great success demonstrates that ASAL's engineers are fully competent and have acquired a great *autonomy* through this programme" [13 - emphasis added]. Even in the case of the most recent satellite, Alcomsat-1, which was designed, developed, manufactured, assembled, and tested by the China Great Wall Industry Corporation (CGWIC), "an 'important' training programme" formed part of the agreement, with the operation of the satellite to be handled by Algerian specialists [15].

While Algeria provides one of the clearest examples of how African governments are embracing commercial partnerships to increase their own space-related capabilities, similar efforts are under way across a range of African countries. Another excellent example is that of Tunisia. While Tunisia's space sector is not as advanced as that of neighboring Algeria, the "first major private space investment" in the country was made in 2017, whereby a Tunisian company Sfax Technopole (a public limited company incorporated under a Public

Private Partnership [16]) partnered with Telnet and Aerospace Valley Toulouse to make "the Sfax Technopole a center of space, courtesy of the partnership between the Telnet Group and the European leader Airbus Safran Launchers" [17]. The project is said "include the design and construction of an assembly, integration and microsatellite testing facility and the implementation of an engineering center for microsatellites", with the engineering center having three main missions of "engineering and satellite design, research and patents in the field of space and the development of innovative services in space" [17]. This is predicted to create 500 direct and 1000–2000 indirect jobs. As such the Tunisian space sector is set to grow, with the first Tunisian satellite, Challenge One, planned for launch in 2020 [18].

While Africa's domestic commercial space sector is, on the whole, in its fledgling stages, South Africa has emerged as the "undisputed industrial hotspot of Africa's nascent space industry", and it was noted in 2018 that:

> "The commercial space industry era, although still nascent, witnessed the nanosatellite and cubesat bubbles in the major commercial space clusters in the Western Cape. South Africa's commercial space industrial growth did not just happen overnight. It has antecedents and spinoff frameworks that could serve as a model for other African countries who desire to leapfrog their space industry. The South African model features a collaboration between the three major pieces of an industrial ecosystem puzzle – academic institutions, government goodwill and private sector grit. South Africa has a variety of institutions that form a piece of the puzzle in the research & development, exploration and utilisation of space. The institutions form the nucleus of the nation's space industry" [19].

An example of a successful South African commercial space company is the Space Commercial Services (SCS) AeroSpace Group [20], which has, amongst other achievements, contributed South African-developed space hardware (a digital controller unit) as part of the Netherlands-China Low Frequency Explorer (NCLE) as a science payload on the Chang'e-4 satellite [21]. Another example from South Africa is the non-profit organization Foundation for Space Development [22], which wants to inspire Africa's youth by undertaking the "continent's first mission to the moon and transmitting images from either a probe on the lunar surface or from a satellite orbiting it" [23].

From a policy perspective, African countries (and the African Union) have also been making strides. Continentally, the new African Space Agency will support national space programs, driven by the African Space Policy and Strategy (approved by the AU Assembly in 2016), and framed by national policies such as that of South Africa [see 24, 25, 26]. In a broad sense, it has also been increasingly recognized that space can support Africa's development plans and objectives, including in relation to the Sustainable Development Goals 2030 [see 27]. Moreover, many African countries have embraced commercial partnerships in the development of their space sectors, and the African international space ecosystem is set to continue its rapid upward trajectory in the coming years [see 7, 11, and 27 for more in-depth information on the African space arena].

## 4. Conclusion

Clearly, there is increased interest in utilizing space technologies in Latin American and African countries. Although some national governments have begun to develop policies to better support and promote industry, greater coordination and especially financial investment will be crucial in the coming years to support the burgeoning industry. For the time being, commercial partners from other countries are proving to be useful in providing space solutions to address developmental problems on these continents.

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